

Considering COTS

Carol Booth

Introduction

In recent years, the Department of Defense (DoD) has placed increasing emphasis on the use of commercial off-the-shelf (COTS) items. Some have seen the use of COTS as the *silver bullet* that will allow the Services to deploy more capable systems faster and at lower cost. Others have viewed the use of COTS items more skeptically. Many in this latter group believe that COTS cannot work effectively in military systems and that this is just the latest *snake oil*. This article suggests there is a middle ground while exploring some of the issues related to the use of COTS items in military applications.

Background

The military has always used COTS items. Examples include test equipment, staff cars, office equipment, engines for transport aircraft and construction equipment where the military use and operational environment were similar to civilian applications. Since the mid-1980s, there has been an increasing push to expand the use of COTS applications. In 1986, Congress passed legislation requiring the DoD to consider the use of nondevelopmental items (NDI) prior to launching a development program. The Services responded to this legislation by encouraging consideration of COTS items.

In the 1990s, the end of the Cold War led to faster and more sweeping changes in the DoD. The military downsized and budgets declined, while mission requirements shifted to include more military operations other than war and became less predictable. In this environment, developing systems from the *ground up* using military specifications and standards is often not practical. In response, the DoD created Acquisition Reform (AR) initiatives intended to reduce cost and cycle time by applying commercial practices and leveraging the commercial industrial base. The Federal Acquisition Streamlining Act of 1994 and the Federal Acquisition Reform Act of 1996 broadened the definition of commercial items and made it easier to acquire COTS items and modified commercial items. This, together with the realization that leadership in key technologies had passed from the DoD to industry, has strengthened the move to use COTS items in weapon systems.

Characteristics

Effective use of COTS items requires an understanding of the nature of the commercial market. Three *facts of life* are:

- Technology is constantly changing.
- Market forces outweigh DoD needs.
- Vendors control configuration and data.

Rapidly advancing technology yields increasing performance and enhanced product features. Today, the technology cycle for

semiconductors is less than two years.¹ Semiconductor availability drives the configuration of COTS circuit cards. The product support life cycle for electronics ranges from four to six years. Consequently, support plans for COTS items must include provisions to deal with the inevitable parts obsolescence.

The DoD is just another customer in the commercial market place. The DoD's share of the semiconductor market fell from 17 percent in 1975 to 1.3 percent in 1995.² Decisions to discontinue production of particular items are based on market forces and profit. Competing companies race to bring out new products with enhanced features/performance and reduce costs to gain market advantage. As these new products are introduced, older products with limited market share are discontinued. As a result, the DoD must learn to plan for market changes.

Vendors control the internal configuration of their products and all technical data. Availability and cost of components drive configuration changes. Product layout and packaging may be

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changed to gain manufacturing efficiencies or increase yield. A typical COTS single board computer may have hundreds of engineering changes each year. Customers are typically not notified of configuration changes and part numbers are generally not updated.³ For example, the Q-70 Program received replacement circuit cards with a firmware revision and the program office was unaware of the change.⁴ Vendors maintain product data geared to marketing and manufacturing needs. Design details are normally proprietary with only performance and interface data provided to customers. Data available to the DoD is the same as that available to other customers. Vendors determine the data format.

These COTS characteristics yield significant benefits, but also produce challenges.

Benefits

The biggest benefit of using COTS items is the ability to put more capability into the hands of the warfighter faster. This is particularly important as mission requirements become less predictable and as traditional acquisition cycles stretch to 15 years or more. With technology turning over every two years, the long cycle time required for military development virtually

guarantees systems will be obsolete before they are fielded. With COTS solutions, research and development activities are limited to market surveys, testing of sample items and integration activities; hardware production starts as soon as contracts are awarded. Figure 1⁵ shows the impact of using COTS on development time.

Use of COTS items also reduces acquisition costs. Reduced requirements for research and development result in up-front cost savings. Economies of scale achieved by large-scale commercial production runs yield savings in procurement cost. Figure 1 also

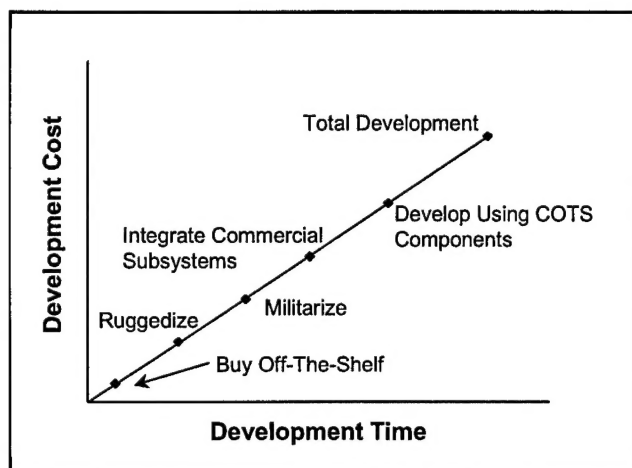


Figure 1. COTS Development Strategy, Cost Versus Time

shows the relationship between various COTS strategies and development cost. Using unmodified COTS items is the fastest and lowest cost strategy. The more modification required, the longer the cycle time and the higher the costs. But even development using COTS components, rather than custom designed, Military Specification (Mil-Spec) components can save significant time and money.

Many upgrade/modification programs have shown that replacement of aging military electronics with higher reliability COTS items reduces operating and support costs. The availability of a commercial support and repair infrastructure saves the cost of establishing military repair capability. Additionally, the overhead associated with these commercial support facilities is spread over the entire population of items supported, commercial as well as military. Vendors may also be driven to hold service costs down to gain market advantage. Replenishment items may be obtained from the vendor on a Just-In-Time (JIT) basis, saving inventory costs.

Use of COTS items reduces the technical risks. For COTS items with a large installed population, performance is well known. A small number of units can be procured for testing and commercial users can be surveyed for performance data. A two-step acquisition strategy where vendors are required to submit bid samples may also be used.

Challenges

There are three main areas where the use of COTS provides significant challenges and potential pitfalls:

- Integration and Interface.
- Military Suitability.
- Long-Term Affordability.

Integration and Interface

In many cases, COTS items do not perform a totally stand-alone function. Often the COTS items must interface or be integrated with other COTS or Mil-Spec items within a system.

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Use of *open systems architectures* minimizes interface problems, but even here there are challenges. Standards developed by industry groups and professional associations are consensus based. Achieving the consensus needed to finalize a standard often takes years. In the meantime, technology moves forward. As a result, approved standards may not adequately address the capabilities provided by the technology available. Industry standards also tend to be less prescriptive than traditional military standards, providing multiple implementation options. Compliance with a standard usually indicates adherence to the core requirements, thus products can comply with the same standards and be quite different.

Vendors often include nonstandard features or *extensions* of the standard in COTS items to incorporate new technology not addressed by the standard and to distinguish products in the marketplace. When COTS items are selected for integration into a system, care should be taken to clearly understand which standard options are required and what non-standard features the selected items incorporate. One of the dangers with nonstandard features is that the system design can become dependent on these extras, limiting choices for replacement items when the original COTS components reach the end of their life. Further, there is no guarantee that products supporting any industry standard will continue to be available for the 20 or more years of a weapon system life cycle. The same can be said for *popular* standards, like Windows NT®. These standards depend on market acceptance. When standard products are no longer profitable, they will disappear from the market.

Another integration/interface challenge is mismatched life cycles. In systems composed of multiple COTS items, the various items are likely to have different upgrade cycles. This is particularly a problem with COTS software. Once the new version is released, it is usually impossible to buy additional copies of the older versions. While the new release is normally capable of reading files generated by the older versions, the old software is rarely capable of reading files generated with the new version. This forces update of otherwise fully operational software.

Evolution of COTS technology can also necessitate changes to Mil-Spec items and system software. When the original COTS components of a system reach the end of their commercial life, they are replaced with *new models*. These new models are usually better and faster. Often the higher speed causes system problems, if custom designed or legacy Mil-Spec components cannot handle the increase in performance.

Military Suitability

Military suitability defines the ability of the COTS item to perform satisfactorily in the operational environment over the long haul. Key elements of suitability are survivability and supportability.

Much of the traditional reluctance to use COTS items in weapon systems is based on the belief that COTS items cannot withstand the military environment. This is a valid concern. However, it is important to understand that many civilian operating environments are also severe. Environmental requirements should be viewed critically. Does the equipment need to operate in an environment where its operators could not function? What are the real temperature ranges the item might be exposed to?

Typically COTS items do not undergo the extreme shock, vibration and temperature testing required of Mil-Spec items. This testing is costly and, from the vendors perspective, the magnitude of potential military sales may not warrant the expense. However, COTS items may in fact be capable of withstanding the required shock, vibration and temperature. Sample items can be procured and tested as part of the selection process. Another approach to survivability issues is to provide protection for the COTS items. For example, COTS items can be housed in a rugged cabinet that dampens shock and vibration.

Supportability, the second key element of suitability, is another traditional area of concern with COTS items. There are very few military systems that do not require some level of organizational or intermediate level maintenance. With COTS items it is important to understand up front exactly the extent of maintenance that must be performed organically. Organic maintenance requirements will drive the supply support, configuration management and data requirements.

Often organic maintenance on COTS items is limited to removal and replacement of the entire COTS item. In some cases, major components (for example, circuit cards) may be removed and replaced. Lack of configuration control and detailed design data preclude effective piece part repair. This represents a real paradigm shift in the military maintenance community. It also means stocking more expensive modules rather than piece parts, thus increasing storage requirements and dependence on supply lines.

Since detailed design data for COTS items is proprietary, the military and the system integrators must rely on the Original Equipment Manufacturers (OEMs) for technical assistance and depot-level repairs. This makes sole source Contractor Logistics Support (CLS) a fact of life for COTS items. Leveraging the commercial repair infrastructure saves the nonrecurring cost of establishing organic depot capability and, when there is a large commercial repair market, can lower unit repair cost.

However, relying on CLS brings risks. When the

commercial repair market is small, the lack of competition will drive up prices. There is also the question of timely availability of CLS to support emerging peacekeeping and humanitarian relief missions or in the event of hostilities. In the past, some contractors have provided on-site support in areas of conflict, but others have not. Longevity of support is another concern. Will the support be available for the duration of the equipment's life cycle? Companies go out of business, merge or move on to newer product lines. *Escrow* of data mitigates the risk of the OEM ending support prematurely. Successful use of this approach requires a mechanism to ensure the adequacy, accuracy and currency of the escrowed data.

Supply support for COTS items also brings some unique challenges. Since COTS items are deployed faster, less time is available for provisioning. Most OEMs do not provide standard military format provisioning data. Either the government or the system integrator must derive the necessary data from catalogs and specification sheets.

Continuing supply support is complicated by parts obsolescence. When the original part is no longer available, the inventory control activity must identify a substitute part. Analyses or tests will be required to ensure the substitute part will perform adequately in field. The ability of the part to function in the operational systems must be verified, as well as its ability to perform in the intended environment. In fact, even when procuring replenishment parts with the same part number, testing may be necessary to ensure function and interface compatibility. As noted earlier, vendors make frequent changes to the internal configuration of COTS items without changing part numbers. In some cases, changes may cause anomalies in system operation.

In addition, documentation provided for commercial users may not be adequate for military use. Commercial manuals inevitably require a military supplement. Also, commercial documentation comes in a wide variety of sizes and shapes. Dealing with dozens of commercial manuals in all different sizes and formats can place an undue burden on the operating forces. To avoid this, it is often necessary to rework the commercial documentation into a standard form, adding another cost.

Long-Term Affordability

Today the emphasis in the DoD is on Total Ownership Cost (TOC). TOC encompasses all the costs to research, develop, acquire, own, operate and dispose of weapon and support systems as well as the cost of military and civilian personnel and business operations of the DoD. It is important to view the use of COTS items from a TOC perspective. Some costs associated with use of COTS items may be difficult to link to specific weapon systems. For example, costs such as ongoing market surveillance to provide a knowledge base for identifying COTS products/technologies with military application and monitoring for parts obsolescence may not be directly linked to weapon systems. Also, costs of maintaining test beds for evaluation of candidate replacement items and testing replenishment items must also be considered. If these costs are included in overhead, the real cost of COTS will not be visible.

The traditional breakout of weapon system life cycle costs is

10 percent Research and Development (R&D), 30 percent Production and 60 percent Operating and Support (O&S).⁶ Figure 2 shows this traditional breakout. It is significant to note that the largest area of savings for COTS is in R&D, traditionally the smallest component of life cycle cost.

The life cycle cost profile for COTS items is distinctly

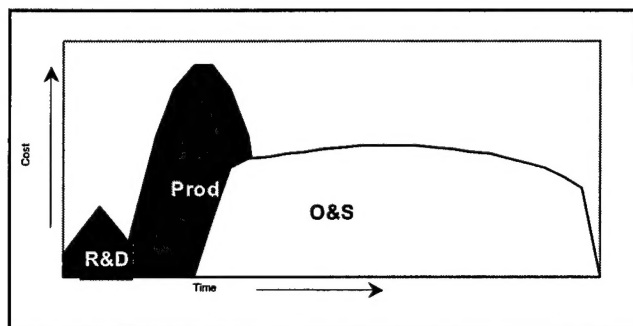


Figure 2. Typical Weapon System Life Cycle Cost Distribution

different from Mil-Spec items. The nature of COTS components tends to change the distribution of costs across the life cycle. COTS solutions require far less R&D and often lower initial procurement cost. But keeping up with evolving COTS technologies and the associated parts obsolescence adds cost. There are two ways of dealing with parts obsolescence, lifetime buys and technology refreshment.

Using the lifetime buy strategy, all the replacement parts needed for the life of the weapon system are bought up front as part of the initial procurement. This increases initial procurement costs and inventory management costs. This strategy might yield a cost profile similar to the one shown in Figure 3. However, there are risks associated with the lifetime buy strategy. This strategy depends on the ability to accurately predict the lifetime

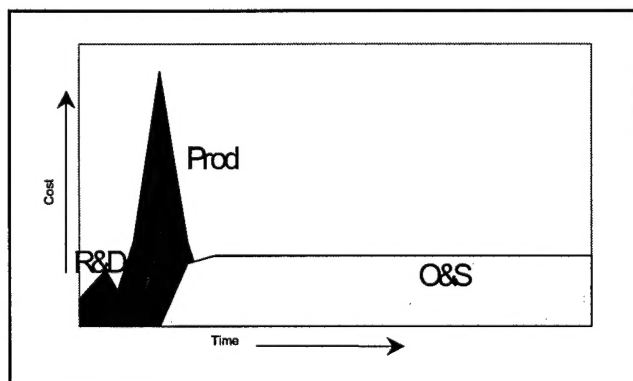


Figure 3. Cost Profile for Lifetime Buy

spares requirement. These requirements, in turn, depend on the length of the systems' life cycle, item failure rates and system usage rates. Errors in estimating any of these factors can result in procuring too many or too few lifetime spares. Either is costly. A significant advantage of lifetime buys is that support resources (for example, technical manuals, supply data and training) remain constant.

Technology refreshment involves replacing the COTS items periodically to keep up with evolving technology. Ideally, the

technology refresh cycles are timed to avoid parts obsolescence. To reduce support risks, a commitment may be secured from the system integrator or OEM to support the COTS item for the duration of the refreshment cycle, or sufficient spares may be procured up-front to last through the refresh cycle. Depending on the technology involved, the refresh cycle may be as short as

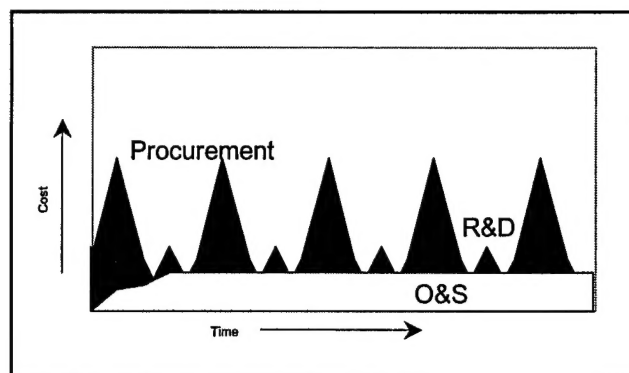


Figure 4. Life Cycle Cost Profile With Technology Refreshment

two or three years and as long as seven years. This strategy results in a cost profile similar to Figure 4. For each technology refresh cycle, some R&D is required to survey the commercial market, test and evaluate products, integrate the new COTS items and perform system tests. Updates to user documentation and training are also required. O&S costs remain low throughout. Technology refreshment has the added benefit of providing enhanced performance, although the enhanced performance can cause problems with the interface to legacy equipment.

One significant risk associated with the technology refresh strategy is that the funds will not be available to implement the technology refresh on schedule. If the planned technology refreshment cannot be implemented, O&S costs will increase until obsolescent, non-supportable items can be replaced. This might result in a cost profile similar to Figure 5.

Alternately, technology refresh may be an ongoing activity rather than a series of periodic events. In this strategy, a sustaining engineering activity, either government or contractor, continuously monitors the commercial market for parts obsolescence and Diminishing Manufacturing Sources (DMS). Whenever a part is about to go off the market due to obsolescence or DMS, an analysis is performed to determine if a lifetime buy should be made or if the part should be replaced. If a replacement strategy is selected, a market survey is conducted, items are evaluated and tested, the selected item is integrated into the system, operating and support documentation is updated and deployed systems are upgraded to the new configuration. The difference between this strategy and technology refreshment is that the cycles are less predictable and a core sustaining engineering function is maintained across the life cycle.

Considerations

Use of COTS items in weapon systems requires: careful analysis of the market place, technology trends and military requirements; consideration of alternate operation and

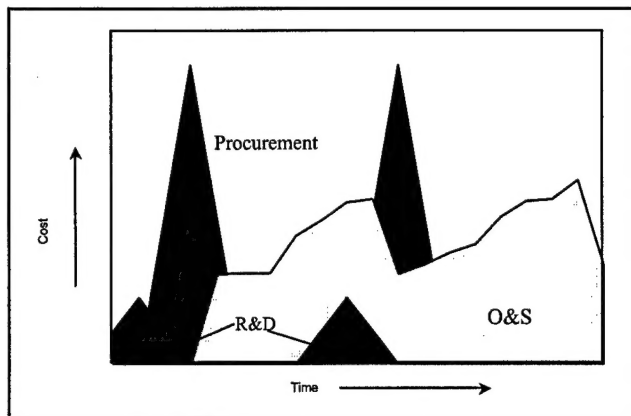


Figure 5. COTS Life Cycle Cost Profile With Delayed Technology Refresh

support concepts and their impact on the ability to meet mission requirements; attention to interface and integration issues; and comprehensive risk management strategy.

Understanding the market is critical. Is the market large or small? Are there many vendors supplying similar products or do one or two large suppliers dominate the market? How big a portion of the market is military? For some products, like rugged disk drives, military sales represent a large percentage of the market. For other products, like single board computers, military sales represent a very small part of the market. What is the *model cycle*, that is how often are new models introduced? Are interfaces standard across the industry?

Considering the nature of the underlying technology trends is essential. Is the technology stable or rapidly evolving? Today electronics technology generations average 18 months, while the technology base for mechanical equipment is much more stable. How is the technology evolving? Is backward compatibility likely with existing items? Is the technology for the COTS items being considered leading-edge, state-of-the-practice or lagging-edge?

Review requirements carefully. What must the item do? What is the operational environment? Overestimating the severity of the expected environment will unnecessarily eliminate many commercial items from consideration and increase costs. Underestimating the severity of the environment could prove to be even more costly if the item procured fails to perform in the field. How firm are the performance requirements?

Examination of support concept alternatives is required. What are the minimum organic maintenance tasks? Is replacement of the entire end item feasible for every failure mode? What is the impact on pipeline spares and transportation requirements? Generally, a maintenance concept based on removing and replacing relatively large system elements will reduce manpower requirements (numbers and skill level), but increase the cost of pipeline spares, transportation and asset visibility. Detailed iterative analyses are needed to assess the overall cost and readiness impact of various support alternatives. Consider how the proposed COTS item support fits with the existing support infrastructure.

Interfaces must be defined completely and comprehensively. Emphasize portability in software and test software on

multiple COTS platforms whenever possible.

Most importantly, understand the risks. Conduct *worst case* analysis and prepare for contingencies.

Summary

Use of COTS items is now a necessity. COTS provides a cost-effective way to get new technology into the hands of the warfighter quickly. Long-term support issues remain, but, as with traditional development programs, careful planning up front will mitigate life cycle support problems.

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Notes

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